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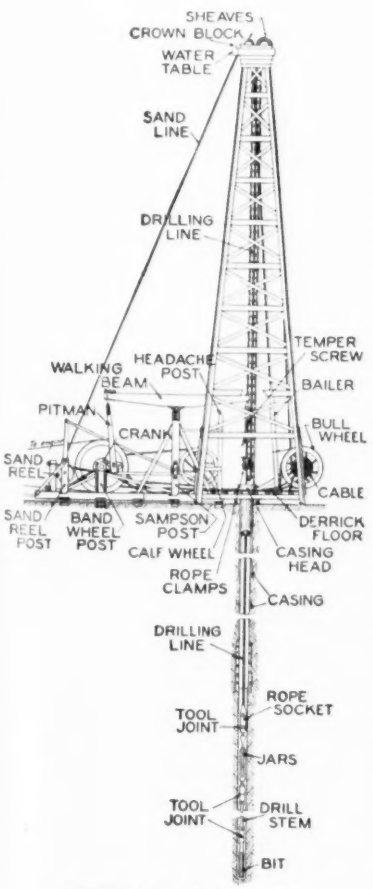
Oil Field Machinery



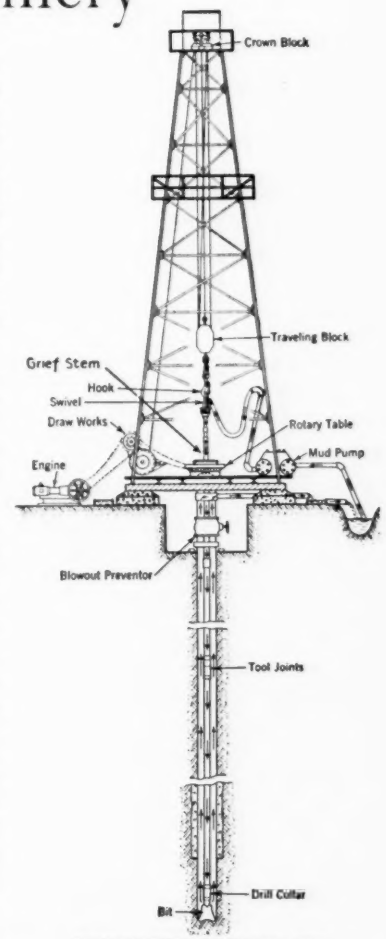
CABLE-TOOL DRILLING RIG

Courtesy of U. S. Steel News, U. S. Steel Corp.

Fig. 1—Showing the major items of equipment with respect to one another.

IN any industry subject to the use of its own finished products for maintenance of productive machinery, there are some who will always be so close to operations as to lose sight of their individual responsibility in the application of these products. Oil field machinery is distinctive in this regard. As the initial stage in the production of petroleum products, it deals with raw materials in fluid bulk form.

The nature of crude oil is not conducive to cleanliness. It is reasonable to expect, therefore, that the importance of lubrication of the machinery employed in its production and handling to refineries will be overlooked. And yet, this equipment is just as costly and quite as carefully designed as any of the machinery employed in the handling of metals, textiles or motor vehicles,—machinery which these very products of petroleum must operate and maintain.

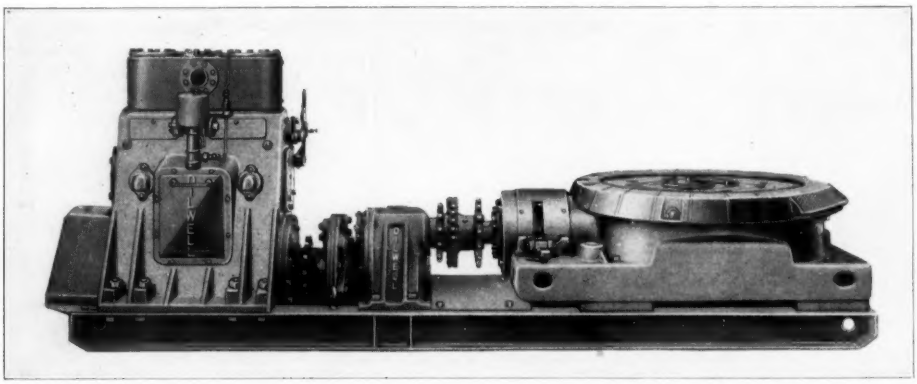


ROTARY-TYPE DRILLING RIG

Courtesy of Intern'l Nickel Co. and U. S. Steel News

Fig. 2—Showing in detail the equipment essential to this modern form of drilling.

While it has been stated that some may have overlooked their responsibility in the maintenance of oil field machinery, others have realized forcibly the relation of lubrication to maintenance and low-cost production. Many of the latter have had to do with the manufacture of such machinery. In this capacity they have been able to observe the value of effective lubrication over a wide range of operating conditions. By reason of this experience they have been most helpful in educating field operators as to the monetary value of the equipment with which they are working, and the benefits to accrue from careful maintenance and parts lubrication.



Courtesy of Oil Well Supply Company

Fig. 3—A rotary drilling unit consisting of a twin-cylinder vertical steam engine; a geared speed increaser and a 27½" oilbath rotary. All are designed for automatic lubrication. The main bearing of the rotary is of the high speed ball type; the pinion shaft being supported by heavy duty roller bearings.

To the layman an assembly of oil well drilling or pumping machinery, constitutes only those most obvious elements—the derricks. They are picturesque when grouped together, and indicative of power. Furthermore, they are a vital necessity in drilling, to enable accurate location of the casing, and to serve as supports for the crown blocks over which certain of the drill cables are passed. They involve no lubrication, however, but do serve as an assistant to lubrication through access to the bearings of the crown block sheaves.

METHODS OF DRILLING

There are two primary methods of drilling, viz.:

The cable-tool or percussion system, and,

The rotary method.

Both, of course, involve derricks as do likewise any of the recent modifications or combinations of these systems.

Cable drilling originated in the early development of the oil industry where the fields involved hard dry strata such as shales, limestones and carboniferous rock formations. It was also well adapted to shallow well drilling, a fact which led later to the use of the less-costly portable unit for drilling test holes. In cable drilling a bit or heavy, sharpened tool is periodically driven against the strata to be drilled, to break or crush its way through by impact. The cuttings or crushed materials are removed by means of a bailer or long tube which is periodically lowered into the hole.

When dealing with soft, damp or relatively wet rock formations, or in localities where a considerable excess of water prevails, rotary drilling is preferred. It is carried out by rotation of the bit which is attached to the drill pipe. This latter is heavier than ordinary well casing, resistant to twisting, and capable of retaining the walls of the hole. Rotary drilling is a boring process; it is usually carried out in the presence of watery mud or slush. This latter serves not only to facilitate the cutting action of the auger-like edge of the bit, but also it washes out the cut materials. To bring this about the above-mentioned mud is pumped down the hollow drill pipe; through perforations in the end of the bit it later finds its way to the space outside between the pipe and wall of the hole. No bailing mechanism is necessary in this type of drilling.

The Necessity of Power

Power is obviously a most important factor in oil well drilling. Regardless of the method employed, the variety of surface machinery must be operated at uniform speed and in complete accord. Steam power, by reason of the availability of oil for fuel, early became the virtual standard.

Steam is flexible, readily handled and unless unduly wet, it is ideally suited to the rough, exposed conditions which prevail around the

average well. Furthermore, steam engines and pumps are rugged and requiring of but little adjustment. Lubrication of their cylinders, valves and external mechanisms is, however, most important, and must be continually maintained, if the necessary power output is to be developed.

One is handling steam under most adverse conditions in the oil fields, hence it is usually quite wet, a factor which imposes a definite responsibility where cylinder oils are to be purchased. To meet wet steam conditions, specialty refinement and compounding are necessary. All this is well known to the refiner; it should be equally understood by the field engine operator.

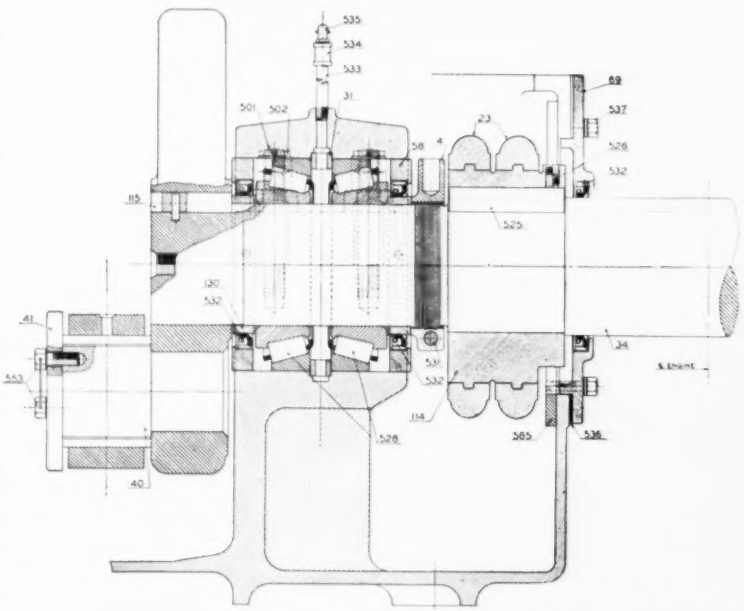
The horizontal, twin-cylinder slide or piston valve engine is usually employed in such service as the medium for furnishing power to the draw works through a sprocket or chain drive. The modern oil-field engine is fully enclosed so that bath or splash lubrication of its external parts is practicable. Cylinder lubrication in turn is effected by hydrostatic or mechanical force feed lubricators with suitable leads to the steam line or intake manifold at the steam chest.

In the interest of reducing line condensation steam piping and boiler insulation should be properly applied and carefully maintained. Boiler pressures may range from around 100 pounds gauge up to as high as 350 pounds. Obviously, the higher the pressure the higher will be the temperature. In addition, the practice of superheating will increase the steam temperature to a much higher degree at times.

High steam temperatures are not difficult to meet in effecting proper engine cylinder lubrication. High temperature with moisture, developed through line condensation or priming, however, may present a severe condition of lubrication. Hence the advisability of reducing condensation as much as possible. Normally a compounded steam cylinder oil will meet these conditions most effectively, the amount of compound or fixed (fatty) oil being dependent upon the quality or percent of moisture in the steam. For the more usual condition of comparatively wet steam a medium viscosity cylinder stock compounded with around six to eight percent of degras or tallow will function effectively. Condensing engines are seldom used, thus eliminating any cause for worry as to presence of cylinder oil in the exhaust. By the same premise a certain excess of cylinder oil can be fed to the engine; unless very high temperature steam is used. This may be good practice, to assure of maximum protection of cylinder liners, for in the horizontal engine one must remember that the lower part of the liner is under considerable pressure due to the dead weight of the piston. Tail rods will of course reduce this load by transforming the pressure to the rod supports.

Cylinder liner wear is also reduced in the vertical, twin-cylinder steam engine as designed for such service. In addition, a totally enclosed crankcase in turn enables bath or splash lubrication of other parts. Steam cylinder lubrication in the vertical type engine will differ but little, otherwise, from that of a horizontal engine. The primary purpose is to use an oil of adequate compound to lather readily with the moisture content of the steam, and sufficient viscosity to meet the prevailing temperature conditions.

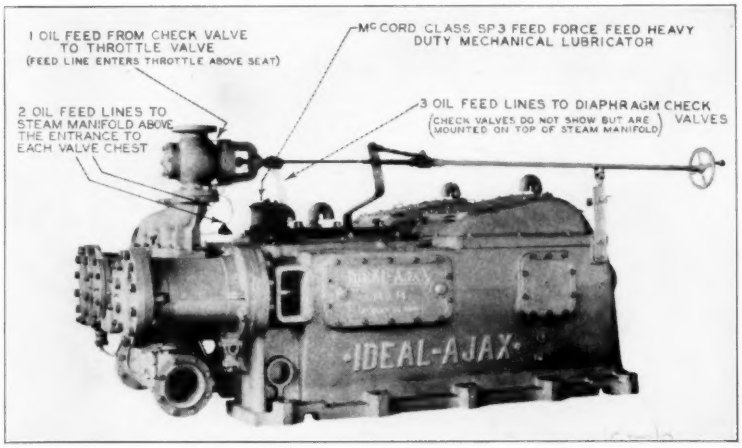
Any such oil will be comparatively heavy in body, and hence may flow with difficulty in cold weather. Where winter-time temperatures may not be extreme as in Texas or California, the question of fluidity is not a problem.



Courtesy of Gardner-Denver Company

Fig. 4—Crankshaft assembly of the Gardner-Denver duplex drilling engine. Part 535 shows bearing cap grease fittings; 528 the Timken tapered roller bearings; and 532 the main bearing and frame oil seal.

Getting into the central west or Pennsylvania fields, however, one must usually study methods of lubricator protection to insure against actual congealment of the oil at low temperatures, with consequent decrease in the amount of oil delivered to the cylinders. To offset this, mechanical force feed lubricators are obtainable equipped with heating coils in the oil reservoirs.


1 OIL FEED FROM CHECK VALVE TO THROTTLE VALVE (FEED LINE ENTERS THROTTLE ABOVE SEAT)
McCORD CLASS SP3 FEED FORCE FEED HEAVY DUTY MECHANICAL LUBRICATOR
2 OIL FEED LINES TO STEAM MANIFOLD ABOVE THE ENTRANCE TO EACH VALVE CHEST
3 OIL FEED LINES TO DIAPHRAGM CHECK (CHECK VALVES DO NOT SHOW BUT ARE MOUNTED ON TOP OF STEAM MANIFOLD) VALVES
IDEAL-AJAX

Courtesy of Ajax Iron Works

Fig. 5—A roller bearing twin cylinder horizontal steam engine equipped with a McCord, heavy duty, force feed mechanical lubricator for cylinder service. The lubricator is driven from the short reciprocating stroke of the valve rod.

Internal Combustion Engines

In some oil field operations gas or Diesel engines have also been adapted for power generation purposes. Obviously, the internal combustion engine eliminates the necessity for steam and boiler equipment.

Where operating in areas productive of a considerable amount of natural gas, the gas engine has definitely proved its value, just as it has in pipe line service. The Diesel or heavy-oil engine, however, may require more or less of a refined fuel or high grade crude; it is therefore best suited to production areas adjacent to refineries.

Horizontal engines of this type are usually regarded as slow speed, as compared with the vertical engine which generally operates at a considerably higher speed. Both types are usually fully enclosed and designed for pressure lubrication. In this connection a highly-refined straight mineral oil of from 300 to 900 seconds Saybolt viscosity at 100 degrees Fahr., should be used according to the horsepower and operating temperature.

METHODS OF POWER TRANSMISSION

The primary purpose of the engine, regardless of its type, is to transmit power to the hoist, draw works or pumping elements. Chain drives and sprocket connections prevail in steam service. Where the gas or Diesel engine is used, however, a gear case or transmission is an added necessity, being in turn connected to the draw works through a chain drive or V-belt.

Lubrication of chain drives is customarily effected by wick or sight feed oilers or by brush application of a comparatively heavy gear lubricant.

In cable-tool drilling power is transmitted directly from the engine to the band wheel, which operates the walking beam. The shaft of this wheel is mounted on babbitt bearings, with two chain sprockets and a rope sheave on one end and a crank on the other. This crank drives the walking beam which operates the drill bit through a wood connecting rod known as the pitman. One of the above mentioned chain sprockets in turn drives the sand reel for the bailer, the other operating the calf wheel which is used to handle the pipe or casing. The rope sheave drives the bull wheel which is used to raise or lower the drill bit. Babbitt is widely used as the bearing metal for the shafting of the above mentioned parts.

Since the speed of the bull wheel controls the speed at which the tools are let into the hole, a band brake is used to regulate the speed of the wheel. This brake is usually a steel band with provision for water-cooling to prevent overheating during rapid drilling. This spray of water imposes another requirement on the lubricants used on certain of the adjacent bearings, in that they must resist any washing action due to contact with water.

The Draw Works

This is a term applied to the hoist or winch mechanism which is used in rotary drilling. Normally it involves sprocket and chain connection from the main engine to the line or drive shaft. On this shaft are mounted three chain sprockets, one connected to the engine, as stated, one to the rotary table and the third to the jack shaft. Chain drives serve as the connections in all cases. The hoisting drum or spooling reel is equipped with a clutch and high and low speed sprockets driven from the jack shaft. Normally the mechanism of the rotary draw works is more simple than the operating mechanisms essential to a standard

cable tool system. The hoisting drum handles the steel wire cables essential to drilling operations between the crown and travelling blocks, and at this point carries the entire weight of the tool string and casing materials. In modern drilling, loads may be severe, units being designed today to handle safely upward of 350 tons working load. Obviously such loads will react upon shaft bearings and chain connections. Sleeve type bearings with provision for either oil or grease lubrication have generally been found to carry these loads quite satisfactorily. When oil lubricated a 300 to 500 viscosity straight mineral machine oil will function satisfactorily; when grease is required a pressure-resistant lubricant is best adapted.

Rotary Operations

The rotary drilling machine is operated through a power take-off chain from the draw works. The principle involved in turning the drill pipe is much the same as that employed in the rear axle and differential assembly in automotive service.

This is accomplished by a bevel pinion and ring gear drive, located on a sturdy foundation at the level of the derrick floor. The weight or thrust of the rotary table is usually carried on ball or roller bearings lubricated from an oil reservoir around the lower race; similar bearings may also be used to carry the pinion shaft.

Naturally the type of bearing employed will dictate the manner of lubrication and type of lubricant. Sleeve bearings, as mentioned above, can be lubricated either by oil or grease through suitable cups or by hand. Ball or roller bearings, however, are pressure lubricated at regular intervals by means of a suitable grease gun using a specially prepared anti-friction bearing lubricant which will resist leakage and break-down.

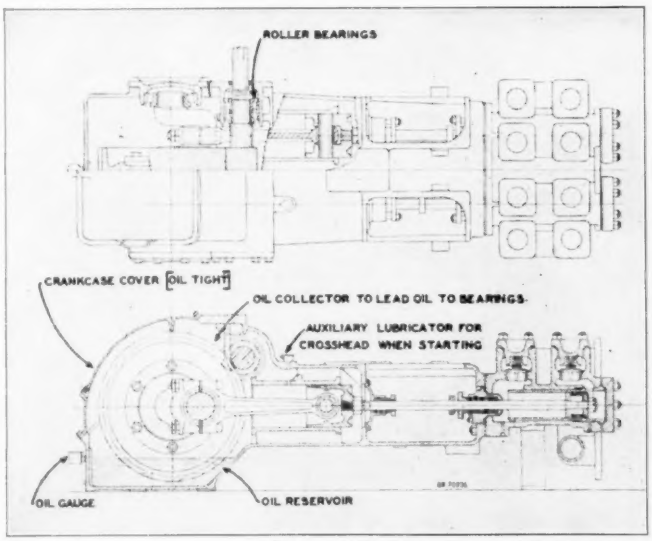
The manner in which gears and pinions should be lubricated will depend upon the installation and type of housing. Where exposed and subjected perhaps to water and dust, a comparatively heavy gear lubricant of from 1000 to 2000 seconds Saybolt viscosity at 210 degrees Fahr., should be periodically applied to the tooth surfaces. Some designers prefer to house the table bearings, gears and pinions in a unit casing; under such conditions the one lubricant can be used for all elements, being circulated by the gear teeth from a suitable bath. The choice of lubricant must be contingent upon the tightness of the housing; usually a heavy automotive gear lubricant will function satisfactorily, although some will prefer a heavy motor oil where their housing will retain same. In such installations the entire bottom of the table may form the oil reservoir.

Blocks and Swivels

Other equipment incident to rotary drilling include the crown block, travelling block and swivel. All must be properly lubricated in order to assure of dependable operation.

The crown block is securely anchored at the top of the derrick. With its companion the travelling block, it carries the steel cable attached to the hoisting drum on the draw works. Each block carries a number of sheaves over which this cable is passed in conventional pulley-block arrangement to give the necessary lifting power. As a result the crown block carries the entire weight of the tool string.

Crown and travelling blocks may be completely interchangeable, hence they are mounted on bearings of similar type. Either bronze-bushed sleeve type bearings or roller bearings can be employed. Grease lubrication by pressure gun is preferable using a pressure-resisting-grease containing an oil of comparatively high viscosity. Lubrication of these bearings must be regularly attended to, otherwise improper functioning of the blocks may result.

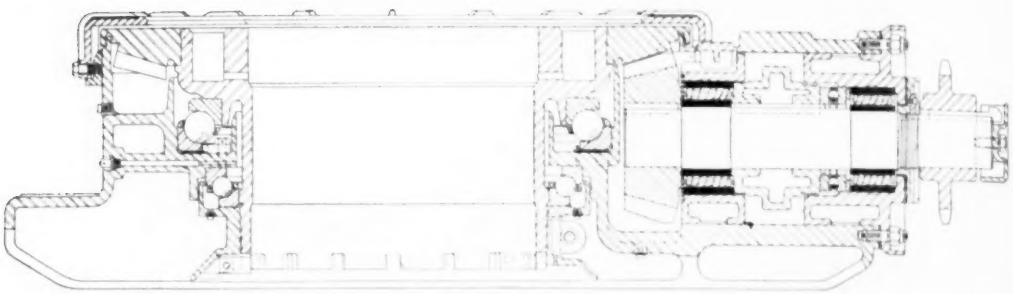


Courtesy of Worthington Pump and Machinery Corp.

Fig. 6—The Worthington enclosed self-oiling horizontal duplex power pump. Note application of Timken flood-lubricated roller bearings at the main and pinion shafts; also provision for auxiliary lubrication when starting.

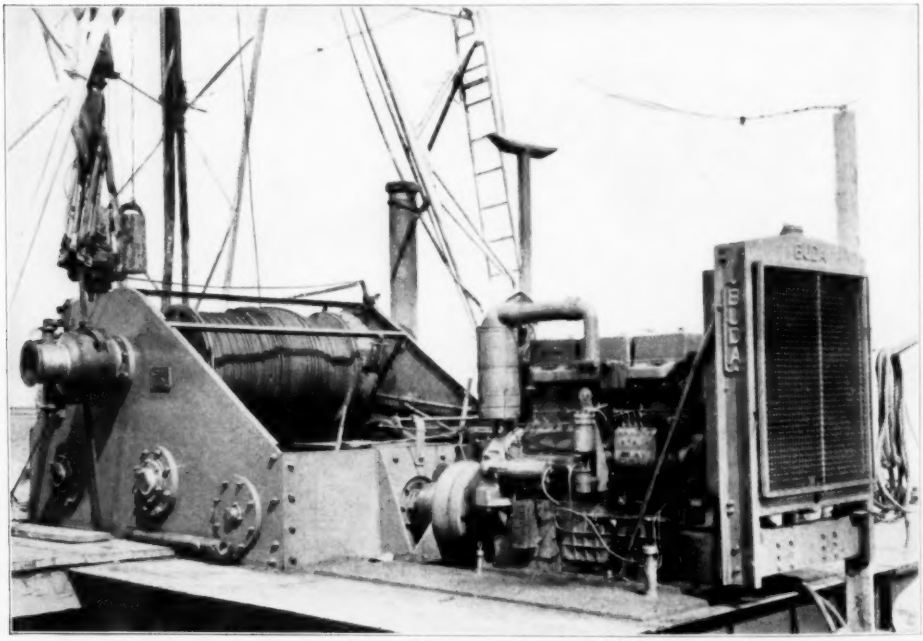
The Swivel

The primary function of the swivel is to enable free rotation of the drill pipe. It is



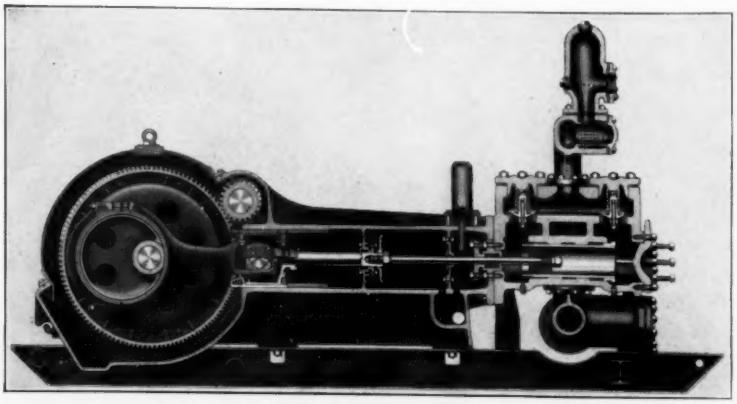
Courtesy of Hyatt Roller Bearing Co. and The National Supply Co. of Delaware

Fig. 7—Detailed view of an Ideal rotary machine equipped with roller bearings on the drive end, and ball bearings for carrying the main load. Automatic lubrication is a feature of this design.



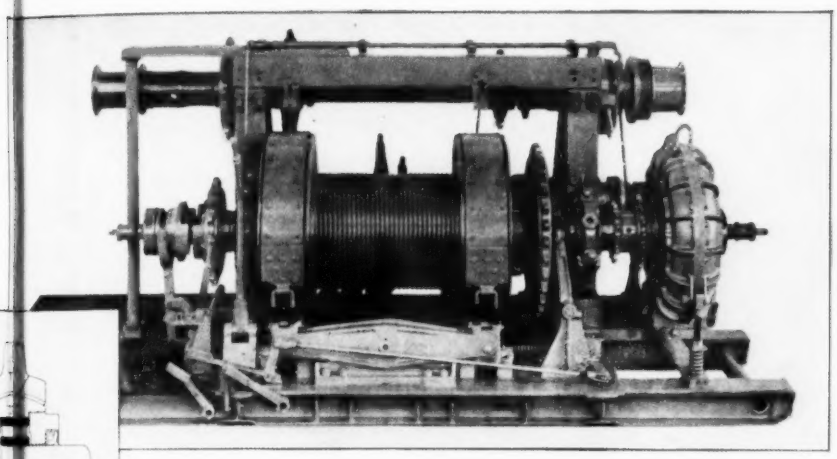
Courtesy of W. K. M. Co. Inc., and Buda Engine and Equipment Co.

Fig. 8—A W-K-M. drilling rig powered by a Buda internal combustion engine. Note exposed nature of the installation.



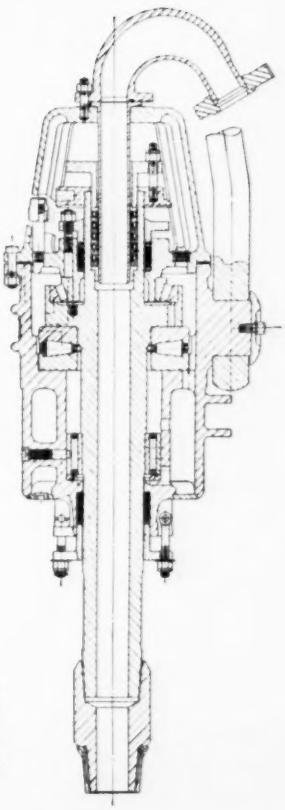
Courtesy of Gardner-Den[illegible]

Fig. 9—(left) Section[illegible] view of a Gardner-Den[illegible] Slush Pump showing type of [illegible]sing for protection of [illegible]cation and the working element[illegible] Flood lubrication is a fea[illegible] of this design, the main gear [illegible]ving as the primary [illegible]buting medium. Main and jack-shaft bearings are grease [illegible]icated, being carried on Timken and Hyatt roller bearings.



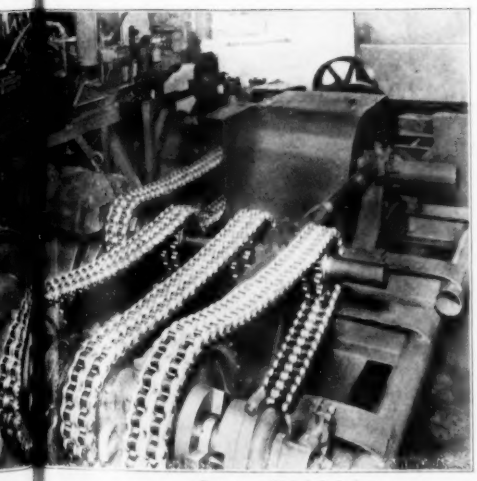
Courtesy of Beaumont Iron Works Co.

Fig. 10—The Hyatt type bearing is also a factor in automatic draw works operation. Note bearing design at left.



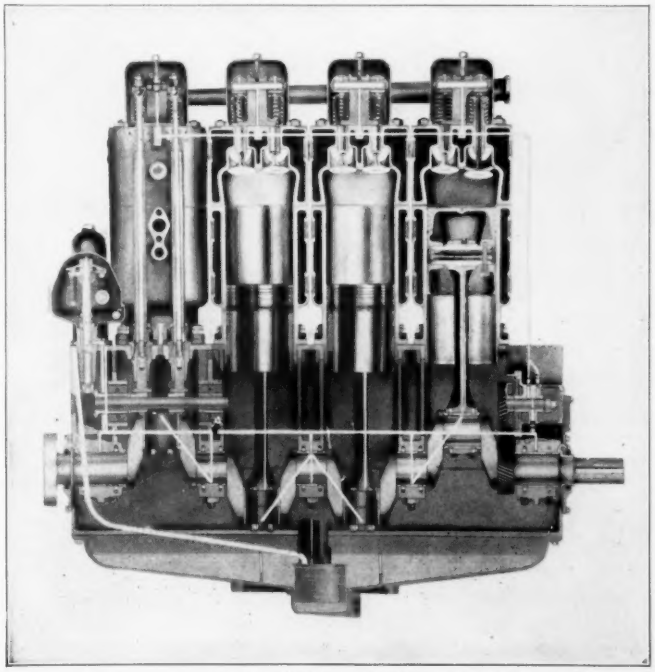
Courtesy of Oil Well Supply Company

Fig. 12—(right) Details of a typical oilbath rotary swivel. This design employs tapered roller bearings for carrying the weight of the drilling string, with provision for automatic lubrication.



Courtesy of Link-Belt Company

11—Showing a typical oil field chain drive installation. Modern e is provide means for automatic lubrication of such chains.



Courtesy of Minneapolis-Moline Power Implement Company

Fig. 13—Constructional details of a typical M. M. engine adaptable for oil field service, showing details of the full pressure oiling system. This engine can be adapted to either natural gas, distillate or gasoline according to field conditions.

located below the travelling block, being suspended from the casing hook by a bail or hoop. On the under side is attached the drill pipe which rotates when operated. The entire weight of the tool string is therefore carried in turn by the swivel thrust bearings; so obviously the latter must be most carefully lubricated to prevent undue wear. The prevailing loads will increase in proportion to the depth of the well.

It is through the swivel that the slush fluid is admitted, which, as already stated, serves to flush cuttings from the hole and enable free rotation of the drill. To bring this about suitable piping and connections are installed to admit of this fluid at the top and to direct it downward through the drill pipe.

By reason of the loads involved, the swivel thrust is usually of the ball or roller type, equipped with an oil reservoir of from ten to twenty gallons capacity. According to the size of the swivel, oil is circulated by the rotation of the bearing elements or by means of a pump. To meet the prevailing loads considerable body or viscosity is essential, the range normally being from 160 to 200 seconds Saybolt Universal at 210 degrees Fahr.; oils within the lighter range are suited to smaller units. Highly refined lubricants of motor grade are best adapted to swivel thrust lubrication.

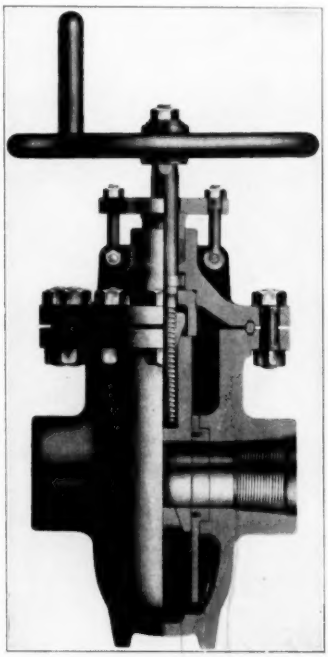
CHAIN AND SPROCKET MECHANISMS

From the mention which has been made above as to chain drives, it can be realized that chain link lubrication must become an important part of the maintenance procedure on any rig. Drive chains of the roller type became an obvious necessity in the early development of cable tool drilling; with the perfection of rotary drilling, however, chain design was given added attention. Improved types of roller mechanisms resulted, heat treated alloy steels were used, and later the silent type of chain became applicable. All are involved in power transmission.

In this development and application of chain designs to oil field equipment it has been most important for the builders to consider load conditions. Chains of extremely high breaking strength have been the result. As strength and durability have increased so has the demand for more positive lubrication. The rugged nature of the roller chain, particularly where built with specially designed pins and bushings, proved it to be especially adapted to such conditions. By improving surface finishes the builders also improved lubrication by creating a design more capable of retaining lubricant. Roller chains are, of course, not as free from noise as silent chains; on the other hand they are not as costly.

The latter embody the highest degree of refinement in chain construction. They include any mechanism which involves parallel series of links which are held in position with respect to each other by means of seat and rocker pins or pins and bushings. By reason of connections of this type silent chains bend most freely, they are, therefore, well adapted to the variety of intricate power transmission work which may be encountered in the oil fields. Where properly lubricated they will also develop but little wear. Usually they are provided with suitable housings and means for automatic circulation of lubricant, as a result cleanliness is another advantage.

The distinguishing feature in the modern silent chain is the link or joint connection. By reason of the design more or less of a rocking action is developed. The chain itself is built up of a number of parallel plates. The entire assembly must, of course, be of sturdy construction in order to prevent change in the distance between centers; this could be caused by wear or vibration. For this reason whenever a chain drive is installed the shafts and sprockets should be tested for levelness, and suitable measurements taken between the respective shafts on both sides of the sprockets to insure that they are absolutely parallel.

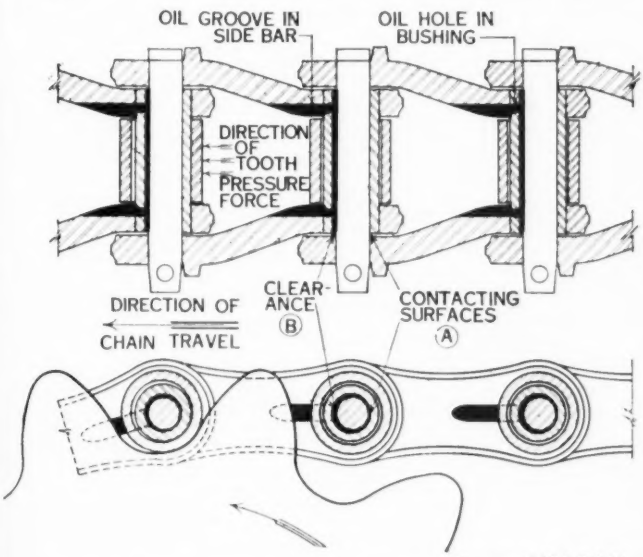


Courtesy of W. K. M. Company, Inc.

Fig. 14—The W-K-M lubricated gate valve. By use of a specially prepared, heavy duty grease the working parts are well protected against corrosion, and friction is reduced to a minimum. With each opening or closing the gate is drawn into the upper or lower cavity where it is surrounded by lubricant. This latter can be renewed through the plug in the bottom.

Lubrication Requirements

In studying the lubricating requirements of any oil field driving chain installation, the operating conditions must be carefully considered. These will include the load, speed, clearances and the extent to which bending or articulation may occur. Each will have a direct bearing upon the ultimate performance which can be expected from the lubricant. Wherever chains can be housed in oil-tight casings, the problem becomes materially simplified, for contamination of lubricant is prevented and lighter bodied products can be used.



Courtesy of Link-Belt Co.

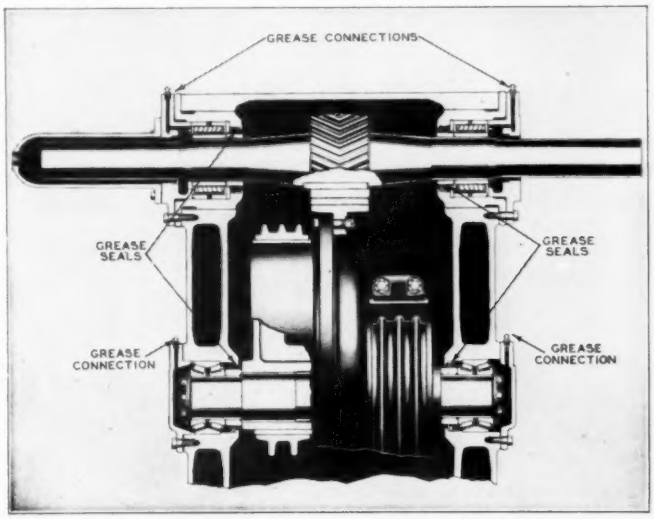
Fig. 15—Lubricating details of the Link Belt "Hyper" oil field rotary chain. Heavy black indicates course of lubricant through the joint clearances.

Load becomes a serious factor wherever a chain may be subjected to sudden starting or stopping. Under such conditions severe shock will oftentimes be imposed on the chain parts. This can be counteracted to some extent by using a lubricant of sufficient body (within the limits of its ability to penetrate) which will serve as a buffer or shock absorber within the clearance spaces.

Speed in turn must be considered since it involves the frequency at which shocks may occur when the chain links engage with the teeth of the sprockets. Obviously, as speeds increase the shocks on each chain link will be more frequent. This will impose a more severe load on the film of lubricant on the contact surfaces which may lead to actual rupture of this film or to its being squeezed out to an excess. The natural capillarity of petroleum lubricants will tend to counteract this reaction. On the other hand the net result will depend upon the viscosity. Under extremely high speeds, if the lubricant is too light in body, this natural capillarity will be reduced and impaired lubrication may result.

In considering bending or articulation as any driving chain passes over gear or sprocket teeth, the amount of potential wear will, of course, depend on the degree of bending or, in other words, the diameter of the sprocket. Bending of this nature imposes wear not only on the actual points of contact between the teeth and the chain but also on the link pin bearings. Obviously, correct chain design has made every effort to eliminate this tendency by confining the necessary rubbing and rolling to the joints themselves. It is, however, almost impossible to eliminate external wear. This, however, can be materially counteracted by effective lubrication and the use of straight mineral lubricants thin enough to penetrate to the internal parts yet sufficiently heavy to maintain an ideal protective film on the external surface.

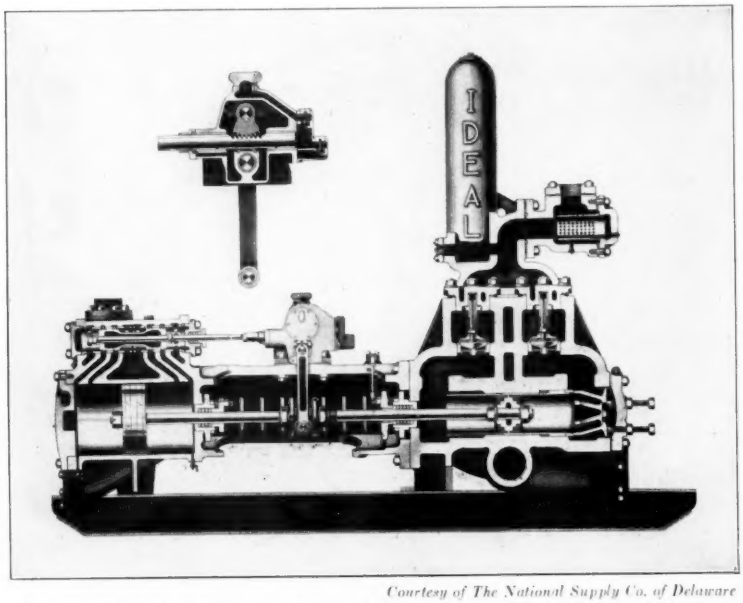
Penetration is, of course, also influenced by the amount of clearance existing between the component parts of the chain. If these clearances are low the lubricant should be of lighter body. This latter will, of course, also be an adjunct in cold starting.



Courtesy of Gardner-Denver Company

Fig. 16—Sectional view showing bearings, gear and eccentric of a Gardner-Denver power pump. Note application of both Timken and Hyatt Roller bearings on the main gear and pinion shafts, with provisions for sealing, and means for re-lubrication.

To most effectively meet these conditions in average oil field operation, it has been found best to use straight mineral lubricants. Where gear and chain assemblies are adequately housed, the minimum viscosity range should normally be around 500 seconds Saybolt Universal at 100 degrees Fahr. According to temperature conditions this may range up to perhaps 900 seconds. For exposed chain mechanisms, however, it will be necessary to go considerably higher in the viscosity range. Under some conditions the automotive type of straight mineral gear lubricant will perform satisfactorily. Under others, involving perhaps higher temperatures with normal clearances or heavy duty link mechanisms, it may be advisable to go as high as 1000 seconds Saybolt Universal at 210 degrees Fahr., or, in other words, using what is normally regarded as a medium viscosity industrial gear lubricant.



Courtesy of The National Supply Co. of Delaware

Fig. 17—Details of the Ideal duplex steam driven slush pump. This unit is provided with an automatically lubricated completely enclosed rockshaft stand to increase the operating efficiency.

Frequency of Lubrication

The nature of the operating conditions will, of course, influence the frequency at which oil field driving chains should be cleaned and relubricated. Under normal conditions where contamination by dust and dirt may not be extreme it will perhaps be only necessary to renew lubricant on exposed chains at perhaps weekly to semi-monthly intervals. Perhaps every three months it may be advisable to wash the chain surfaces and link mechanisms as thoroughly as possible with kerosine to remove non-lubricating material and enable better penetration of fresh lubricant. Chain manufacturers of course will recommend entire removal of the chain from the assembly and complete immersion in a bath of kerosine. This is especially advocated in connection with silent chains by reason of their intricate link mechanism and the possibility of increased wear. On the other hand, the average silent chain will be more completely protected against entry of dust and dirt than will a roller chain assembly and by virtue of the means provided for automatic circulation of comparatively light oils, it can usually be maintained in cleaner condition.

We are more concerned with the heavy duty exposed roller type of chain which may be exposed to the weather and the possibility of contact with considerable dust and dirt, especially in the southwest under dust storm conditions. Where chains of this type have been specially designed and are built of selected steels adapted to heavy load conditions, the cost of chain replacement may become a serious item if lubrication is neglected. Chains of this type, therefore, should be given very careful consideration for, obviously, any chain failure may affect the operation of the draw works and, in fact, the extent that drilling might have to stop while repairs are being made.

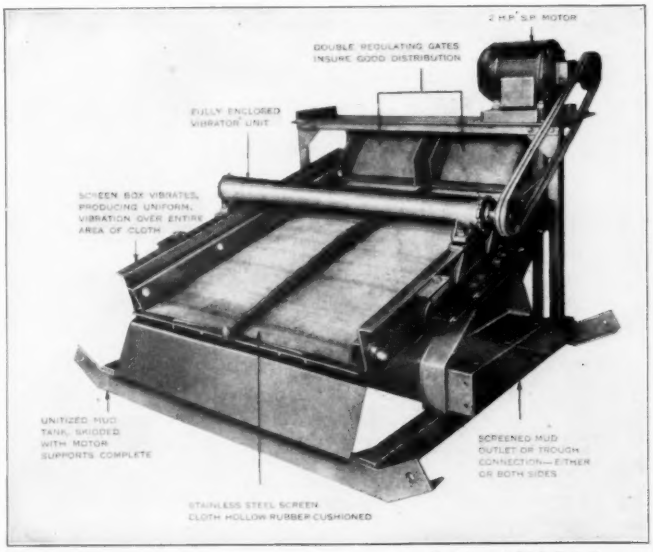
PUMPING OPERATIONS

Due to the fact that the rotary rig involves wet drilling, constant circulation of a watery-mud or slush must be maintained. This requires an installation of comparatively heavy duty pumps which may serve one or more rigs according to the extent of operations. In the parlance of the oil fields this fluid is normally termed rotary mud. Its primary function is to serve as a carrying medium to remove the cuttings and sand which are developed during the process of drilling. These so-called foreign materials must be continuously pumped to the surface otherwise the drill would become clogged.

Rotary mud is preferred to water due to the increased body and greater ease with which cuttings are held in suspension. Later, however, this very property may hinder proper separa-

tion and reclaiming of the mud for re-usage. It is of further advantage to remove sand, shale and rock particles in order to protect the working elements of the pumping system. Here, if there is an excess of abrasive matter, pump liners may become prematurely worn and valve motions impaired.

For this reason, considerable attention has been given to developing suitable means for cleaning rotary mud. For this purpose the shaking screen has been widely adopted by reason of its ability to separate the heavier more abrasive particles from the muddy fluid without materially affecting the clay content or reducing the body.


2 H.P. S.P. MOTOR
DOUBLE REGULATING GATES INSURE GOOD DISTRIBUTION
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SCREEN BOX VIBRATES, PRODUCING UNIFORM VIBRATION OVER ENTIRE AREA OF CLOTH
UNITIZED MUD TANK, SKIDDED WITH MOTOR SUPPORTS COMPLETE
SCREENED MUD OUTLET OR TROUGH CONNECTION—EITHER OR BOTH SIDES
STAINLESS STEEL SCREEN CLOTH HOLLOW RUBBER CUSHIONED

Courtesy of Link-Belt Company

Fig. 18.—The Link Belt vibrating rotary mud screen. The operating mechanisms of this unit are self contained to assure of protection and more dependable lubrication.

Pump Design

Experience has indicated that the reciprocating duplex piston or poppet valve type of pump is best suited to the handling of the average mud or slush employed in rotary drilling. As already implied, the function of the pumping system is to supply the slushing fluid to the bit through the swivel and drill pipe. High pressures are usually necessary, ranging from 750 to 1200 pounds per square inch, although the modern heavy duty slush pump will be capable of functioning up to 2500 pounds safe working load.

The method of drive will, of course, depend upon the design, and the means provided for power take-off. Common practice is to drive through a chain and sprocket connection from the main engine.

In the maintenance of oil field pumps it is most important to provide for adequate protection of the driving gear or power end against entry of slush, mud or other foreign matter. For this reason designers have planned for housing of these mechanisms in a suitable base casting, covered with a sheet metal hood. By gasketing the joints, and adding the further provision of a mud stop head next to the fluid end stuffing box, to divert any leakage of mud or slush fluid past the stuffing box into the sump below, contamination of lubricants is effectively prevented. An oil stop head can also be employed to prevent loss of lubricant along the piston rod.

The reciprocating piston or plunger pump is extremely flexible as to speed, load and pumping capacity. All duplex reciprocating power pumps, however, are subject to pulsation, a fact which has caused some builders to provide a surge chamber. This latter is usually charged with compressed air to take care of air absorption by the fluid at higher pressures. Such air is usually taken from a small auxiliary compressor or from the Diesel, where an air injection engine of this type constitutes the main power plant.

In other respects the reciprocating pump is a durable, dependable unit capable of holding up under the most adverse operating conditions. Sliding motion will largely predominate at all points beyond the drive end. Here, however, the type of motion will depend on the means whereby reciprocation is brought about. The use of an eccentric mechanism with the drive developed by a herringbone gear and pinion assembly, will enable the use of roller bearings on the pinion and gear shafts. Elsewhere the sleeve type bearing as customary in standard steam pump design will predominate.

Lubricating Requirements

Pump lubrication can be regarded from two angles: (1) the steam end, where steam cylinder oils must be applied as in the case of the conventional steam engine, and (2) the power end where power is transmitted to the pump by chain connection from the main engine.

Steam cylinder lubrication has already been discussed. In part the mechanisms of the power end have likewise been taken up. Usually the oil field pump will have its power end more effectively housed than the average power or pumping station unit. This enables more complete adoption of flood lubrication which is especially advantageous when gears or antifriction bearings are employed or where sleeve

bearings on connecting rods or crank pins are set with close clearances.

In some designs employing roller bearings designed for grease lubrication, provision is made for individual application of grease via piping and pressure gun fittings located outside the housing.

In planning for the lubrication of the working mechanisms in the power end of a gear pump it is important to remember that certain of these parts will be subjected to pressures commensurate with the duty involved or the pressure that must be pumped against. As these latter are dependent to some extent upon the viscosity or body of the fluid being handled, it is obvious that the nature of the mud or slush used in rotary drilling may develop quite a resistance to pumping and thereby a heavy load. For this reason certain builders prefer

Courtesy Emsco Derrick & Equipment Co.

Fig. 19—The Emsco Type A-50 6-Sheave Crown Block. This unit is designed for automatic lubrication of the wheel bearings for the purpose of assisting them to carry their loads and to protect them against weather conditions.

to recommend an extreme pressure lubricant for their units.

Cleaning Rotary Mud or Slush

There are certain very definite advantages in re-using slush on many operations where water conditions may require economy or where it may be necessary to add special clays due to deficiencies in the natural muds. In order to attain this objective a method of screening by means of an oscillating or vibrating screen has been perfected using the type of screen developed for the coal industry. This is a self-contained unit consisting of a screen deck

Courtesy Emsco Derrick & Equipment Co.

Fig. 20—An Emsco Travelling Block. Here again, on one of the heaviest duty pieces of equipment in the oil fields, automatic lubrication has been found to lead to most dependable operation.

carried in a suitable box. Vibration is brought about by a rotating shaft, an arrangement of out-of-balance pulleys and a spring assembly. It is normally set in an inclined position to allow the mud or slush to flow over the screen deck, which removes sand, shale and rock particles, discharging same into a reject pit, the fluid meanwhile passing through the screen for delivery back to the slush pump. Such a screen serves an added purpose in that it frees the slush fluid from gas, thereby aiding the pumps to maintain their output.

Lubrication of a vibrating screen is largely confined to the rotary shaft which turns over about 1800 r.p.m. This shaft is normally mounted in sealed anti-friction bearings provided with means for pressure grease lubrication.

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